

Diffusion Machine

This document describes a perpetual motion machine known as a perpetuum mobile of the second kind, i.e. one that, if it worked, would violate the second law of thermodynamics and convert heat at ambient temperature into useful work. In this context, “Useful Work” is a bit of a misnomer because the amount of power produced by a machine of any reasonable size would be negligible. Nevertheless it is of some theoretical interest.

A bare description of the machine might make the reader admit that there appeared to be a source of free energy without it being at all clear where that source came from. So first it is necessary to explain how ambient heat is used. A machine that converts ambient heat into work has to get colder than its environment; otherwise it will not be able to absorb that ambient heat.

Imagine you have a column of liquid in which is dissolved a solid that is denser than the solvent. Imagine further that the concentration of dissolved solid is greater at the bottom of the column. This is not a sustainable situation. The concentration will eventually be equal throughout the column. The dissolved solid will diffuse upwards. Random motions of the solute due to thermal agitation will take it upwards, and if there is less solute at higher levels, then there will be a net drift upwards. Since the solute is heavier than water, this drift will raise the centre of gravity of the column. This constitutes a rise in potential energy of the column. The energy has to come from somewhere, and it should be obvious that source of the energy is the thermal agitations of the solute molecules. As a solute molecule moves upwards (and replaces a lighter solvent molecule that moves downwards) it loses some of its kinetic energy. This kinetic energy was imparted to it from ambient heat. It consequently has less kinetic energy to return to the heat pool when it collides with another molecule.

The Machine

The machine is shown in the drawing on the next page.

The wide column contains a solution that is denser than water. It is connected to tubes containing water at both the top and bottom via semi-permeable membranes. The pressure in the column is raised to slightly above the osmotic pressure¹ of the solution so that the tube connected to the top (the upper tube) is able to maintain a small head of water. The pressure difference across the bottom membrane is exactly the same since the concentration of solution is the same. However the tube connected to the bottom membrane (the lower tube) is able to support a greater head of water since the solution is denser than water. Thus, as shown, the lower tube will overflow and will drip into the upper tube.

So far, all has been described as it would be in the steady state with no net flow around the system. As soon as water starts to drip into the upper tube, there will be a flow of water into column via the top membrane and out of the column via the bottom membrane. This will result in a concentration gradient up the tube. As a result, the head of water in the lower column will drop slightly and the head in the upper column will rise slightly, so reducing the flow. However the flow cannot cease completely because there is a steady diffusion of the solute up the tube.

¹ Osmotic pressure is defined as the pressure difference required across a semi-permeable membrane to prevent any flow of solvent through the membrane.

Note that although the machine involves semi-permeable membranes and osmotic pressure, it does not rely on the phenomenon of osmotic pressure for its operation. Osmotic pressure is actually a bit of a nuisance since it means that the membranes have to be made strong enough to withstand it. That is why I have called it a diffusion machine rather than an osmosis machine. In any practical design of such a machine, it would be preferable to use a solute with a high molecular weight to keep the osmotic pressure to a minimum. It would obviously also be of advantage to use a solute with a high density of solution.

Design for a Perpetual Motion machine
(R. Lerwill: 21/9/2003)

